STEPS TOWARDS DEVELOPING A RISK ASSESSMENT FRAMEWORK FOR COASTAL PLANNING

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Abstract

Within most states and territories of the Australian Commonwealth, local government is responsible for making front line decisions about coastal planning and management. State and territory governments commonly provide roles in funding, policy direction and decision support. Recently, in the face of climate change uncertainty, risk assessment has become a popular tool to inform coastal planning and management across Australia. Over the past 10 years or more, a variety of approaches, all referred to as 'risk assessment', have been developed and applied. In 2015 the University of Newcastle was engaged by the National Climate Change Adaptation Research Facility (NCCARF) to review and assess a wide range of coastal risk assessment case studies from across Australia under a targeted program of research in support of the development of NCCARF's Coastal Climate Risk Management Tool "CoastAdapt". Initially, our approach involved splitting the standard risk assessment process (ISO31000) into its component steps and developing a rubric for 'scoring' studies against conformance with the standard approach. Subsequent follow-up contact was made with appropriate staff from the local government authorities that had performed comparatively well using this method to examine whether the approach taken had provided a robust basis for adaptation. The process was necessarily subjective. However, the results indicated that close adherence to the ISO31000 standard is one strategy that can be adopted to maximise the likelihood of overall success. Another key factor in achieving better outcomes appears to be an ongoing, high level of commitment, coordination and overview of the risk management process by local government staff. Aspects that also seem to contribute to successful risk assessment and follow up actions include clear guidance from state government alongside clear opportunities and pathways for funding. Conversely, absence of these elements can be detrimental to the success of the risk assessment and follow up activities.

Background

In Australia, local development planning and consent is principally the responsibly of local government. Therefore, local government needs to plan for future climate change and incorporate climate change considerations in development consent decisions. In comparison, individual state and territory governments provide the legislative and policy direction, funding and technical support, within which coastal management and planning for coastal climate change needs to be undertaken. Coastal councils have responsibility for land use planning decisions adjacent to, or in close proximity of, the coast. Some of these decisions should involve the consideration of risks relating to those processes and

attributes that are of importance to the coastal zone, which may impact on settlements and infrastructure sited therein.

At the present time, the approach of different state and territory governments and the legal and policy environment is varied. This means that specific advice, for example, on methods that should be applied for risk analysis cannot be laid out as being appropriate for all jurisdictions. The work undertaken for this project has relied heavily on a review of available literature from the past 10 years. Pursuing the aim of identifying 'best-practice' risk assessment, our literature focused on Australian case studies of coastal risk assessment, within the context of coastal adaptation.

Of particular concern to coastal local councils is uncertainty surrounding the way in which the coast will evolve in future decades (and, in some cases, centuries), particularly under the influence of sea-level rise. This evolution will impact upon coastal societies, environments and economies.

The uncertainties associated with risks considered in this report arise from:

- The uncertain amount of sea level rise that will occur over different time frames, and its interaction with ongoing climatic variability. We consider that sea level rise is the quantifiable variable of most concern;
- Future changes to storm behavior and subsequent storm surge characteristics are uncertain. As the scientific evidence firms enough to provide reasonable estimates at the scale required for planning by local government, consideration of those impacts will become easier;
- The uncertain geomorphological response of the coastline with rising sea levels and changes to storms; and
- The uncertain extent, nature, resilience and value of assets that may be threatened by sea level rise, noting that asset values may be environmental, social or economic; tangible or intangible.

Due to the prominence of uncertainty, risk management has emerged as a preferred approach to coastal planning (Department of Environment and Heritage Protection, 2013; Department of Sustainability and Environment, 2012; OEH, 2013). In Australia, this is occurring in a fragmented manner with a number of competing approaches to risk assessment presently being applied.

The international standard for risk management (ISO 31000) was adopted as the basis for this work. This was considered optimal, recognizing that the particular assessment undertaken for coastal climate change risk needs to fit within the broader enterprise wide risk management environment adopted by the local council being considered. ISO 31000 regards risk assessment as comprising (i) risk identification; (ii) risk analysis; and (iii) risk evaluation. However, these activities cannot effectively occur in isolation and our assessment also considered the need for effective risk context establishment and communication/consultation activities. In addition, our assessment considered strict adherence to the nomenclature presented in the standard as being most desirable, given the significant potential for confusion arising from non-standard and inconsistent definitions of risk related terms.

Methodology

ISO 31000, its associated handbooks and related relevant standards such as AS5334 (Australian Standards, 2013) were reviewed to develop a rubric against which to assess previous coastal climate change risk assessment projects. The result is presented in **Table 1.** The adopted weightings are necessarily qualitative, but were derived based on experience, discussed among study team members and forwarded through to staff at NCCARF for final feedback prior to adoption.

Relevant case studies were identified following the methodology adopted by a recent state-of-play literature review prepared by NCCARF (2015), constrained and updated to include more recent work around Australia. In summary, the following case study characteristics were targeted:

- Studies were to be Australian and geographically specific (i.e. coastal), preferably carried out at the local government level;
- Studies needed to be completed as part of an overall process involving climate change adaptation;
- Studies needed to incorporate at least some of the stages of risk assessment, as defined by ISO 31000; and
- Studies needed to have been undertaken during the past decade.

Using these methods, 28 individual Australian coastal climate change risk assessment studies were identified. The list is not considered to be exhaustive, but is considered a reasonable sample size for identifying notable trends in past performance with Risk Assessment. Of the 28 studies identified, not all dealt specifically with all risk assessment stages, meaning that the sample size for each stage was less than 28. The sample sizes are presented in Table 2.

Each study was reviewed in turn, with particular focus paid to the summaries, conclusions and sections that dealt specifically with aspects of risk assessment. A review sheet was established for each study, containing the questions presented in **Table 1** and a space for recording observations of relevance against each question. These observations were essentially qualitative in nature. No scoring was undertaken at this point in time.

Once each study had been reviewed in this way, the answers to each individual question were grouped. In other words, the answers for Question 1 were collated so that the observations made for all studies relating to Question 1 could be compared side by side. When statements were grouped, this was completed in such a way as to remove identifying information, meaning that each answer was not immediately relatable back to the study to which it referred.

Table 1: Assessment Table for Coastal Climate Change Risk Assessment Projects

Assessment Stage	Relevant Questions	Weighting	Stage Weighting
Establishing the Context	Has the scope of the risk assessment been adequately defined, including the time frame and geographic extent?	2.5	**15.0**
	Have stakeholders been identified?	1.5	
	Have the relevant legal requirements, standards and policies been identified?	1.5	
	Have relevant risk criteria been established at the outset of the study, including establishment of the way in which risks will be evaluated, including consideration of whether quantitative or qualitative measures might be applied?	2.5	
	Were stakeholders appropriately involved in the determination of risk criteria as part of context setting exercises?	2.0	
	Prior to Risk Assessment being undertaken, were suitable efforts made to understand the *external* context and environment for the risk assessment?	1.5	
	Prior to Risk Assessment being undertaken, were suitable efforts made to define the *internal* context and environment for the risk assessment?	1.5	
	Does the method incorporate an up-front focus on the objectives of local government and have those objectives been well defined?	2.0	
Risk Identification	Was a systematic method used to identify the risks?	3.0	**10.0**
	Have the views of stakeholders been appropriately incorporated into the risk identification process?	4.0	
	Are risk descriptions presented, including consequences, their impact on objectives, the risk sources and how they arise from the environment, along with the central event itself?	3.0	
Risk Analysis: Likelihoods	Has the best available information been used to assess likelihoods and is use of the data justified?	8.0	**25.0**
	Have suitably robust methods been used to assess the likelihood, given the available data and study constraints, and has use of those methods been justified? Is uncertainty explicitly addressed?	12.0	

Assessment Stage	Relevant Questions	Weighting	Stage Weighting
	Has the scale of likelihoods been determined sufficiently in a way that is consistent with well defined "risk criteria"?	5.0	
Risk Analysis: Consequences	Has the best available information been used to assess consequences and is use of the data justified?	8.0	**25.0**
	Have suitably robust methods been used to assess the consequences, given the available data and study constraints, and has use of those methods been justified?	12.0	
	Has the scale of consequences been determined sufficiently in a way that is consistent with well defined "risk criteria"?	5.0	
Risk Evaluation	Has risk evaluation been undertaken?	5.0	**10.0**
	Is the method of risk evaluation consistent with the established risk criteria and the likelihood and consequences assessments?	3.0	
	Has the risk evaluation clearly indicated those risks that need further consideration?	2.0	
Communication and Consultation	Have stakeholders been informed of the methods used in risk analysis and are they aware of the justification for use of those methods?	4.0	**15.0**
	Was the knowledge of stakeholders leveraged to obtain information on the likelihood and consequences of risks?	7.0	
	Have the outcomes of the risk assessment been adequately communicated (i.e. quality of reporting).	4.0	

Grouping the statements next to each other, allowed the assignment of scores in accordance with **Table 1** to each individual response. The relative score given to each study was therefore consistent across all studies. Some questions were not of relevance to some studies. For example, in some instances, it was clear that only hazards were being considered, meaning that questions relating to the consequences of those hazards were irrelevant to that particular study. In this case, they were assigned a value of 'N/A' for subsequent filtering.

Table 2 Sample Size of Studies Specifically Dealing with the Different Risk Assessment Stages (Total 28)

Risk Assessment Stage	Sample Size
Establishing the Context	20
Identifying Risks	23
Risk Analysis – Likelihoods	26
Risk Analysis – Consequences	24
Risk Evaluation	21
Communication and Consultation	27

Results

The outcomes of the scoring process described above are summarised below in accordance with the risk assessment "Stages" of **Table 1**.

Establishing the Context

The average score for assessed studies was 7.8 out of a possible 15 (sample size 20) and was slightly negatively skewed (Figure 1). No study scored perfect marks. The highest score was 13/15.

While ISO 31000 does not include *Establishing the Context* as part of "Risk Assessment", it makes sense that study reports should have a background summary of the reasons why and context within which the report is being undertaken. This understanding is essential as a base for justifying the scope and approach taken during risk assessment.

For the most part, studies tended to document the subject geographical extent and outline the hazards of concern as part of the introduction to the report. However, while this establishes the scope, the consideration of issues such as internal risk environment and the objectives of local government were poorly considered. These issues are fundamental in affecting the willingness and ability of local government to adequately manage risk.

Furthermore, the legal / regulatory environment which establishes the various responsibilities of local government was often either not documented or poorly understood.

It could be argued that some of these contextual issues are inherently understood and that the risk assessment can be completed in isolation with no need to document the context. But this approach is inappropriate for reports that are destined for scrutiny by the general public and a wider range of community groups and government stakeholders that may not otherwise have a clear picture of the objectives and scope of responsibilities of local government. Furthermore, without setting a firm foundation for the remaining risk assessment, it is easy for remaining stages of the study to become derailed. For example, it is impossible, without understanding the objectives of local government, to identify those risks that are of concern to local government.

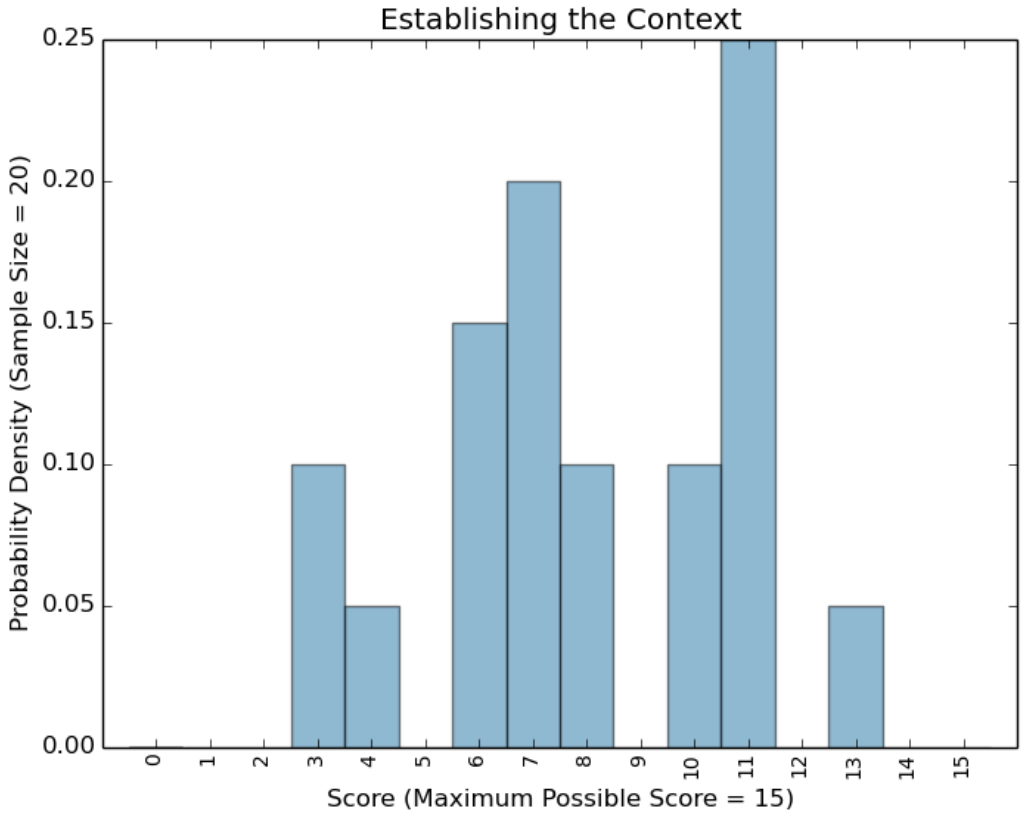

Figure 1 Histogram of Study Results for "Establishing the Context"

One area where mixed results were achieved was that of risk criteria. Many of the studies reviewed were completed using funding from the former Department of Climate Change, under the Local Adaptation Planning Pathways (LAPP) program. One of the criteria for that program was that the methodology outlined in guidelines published by the (then) Australian Greenhouse Office (Broadleaf Capital International and Marsden Jacob Associates, 2006) be applied to the risk assessment. That document provided clear guidance on the risk criteria to be applied and a number of studies performed well in that regard. In the absence of those guidelines, it was not uncommon for very limited attention to be paid to these "criteria for success" at an early stage. It is very useful for these to be

considered and documented up front during the risk management process. The alternative of waiting until risk analysis is completed leaves the door open for a rubbery consideration of what would be acceptable, influenced by a "desirable outcome" which is determined by factors that are not of primary relevance to the risk assessment process (such as political objectives or ideological beliefs).

It is clear that establishing the context is critical for successful risk assessment. It appears that, for coastal management around Australia, it has rarely been well executed. There is certainly a need to provide clear guidance for this stage of risk assessment.

Risk Identification

The average score for assessed studies was 3.9 out of a possible 10 (sample size =23) and was noticeably positively skewed (Figure 2).

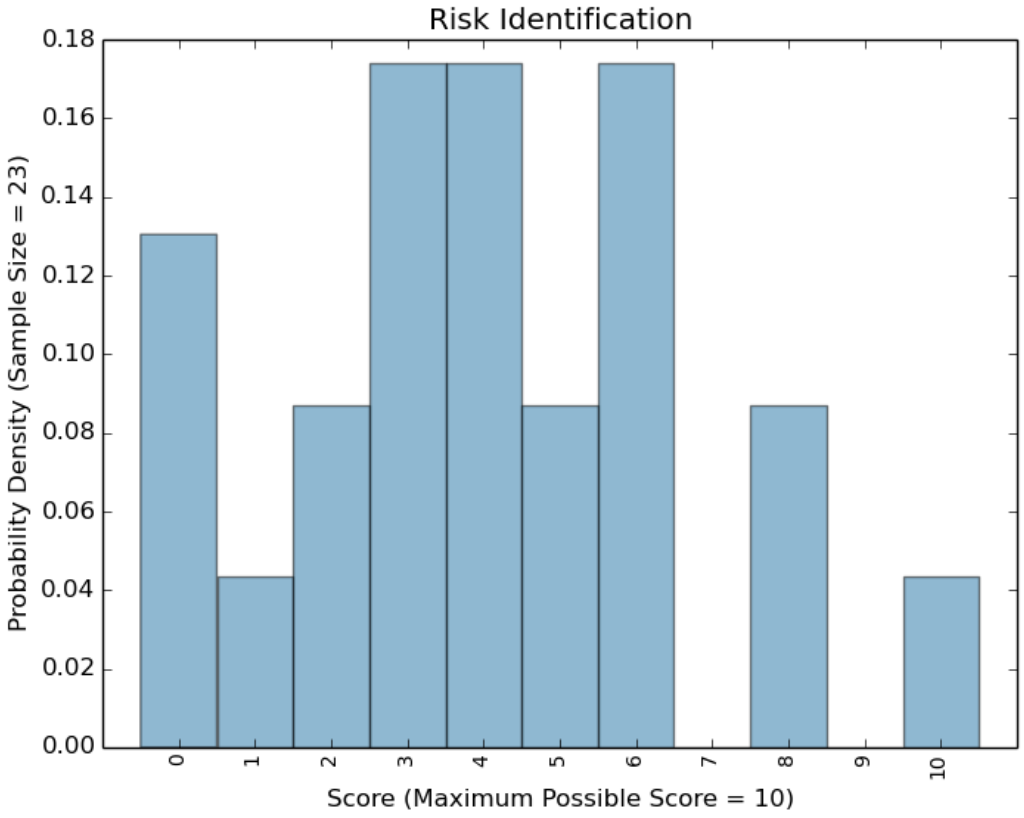

Figure 2 Histogram of Study Results for "Risk Identification"

Risk Identification was generally completed poorly and the overall performance was lower than for establishing the context, although two studies did score full marks. Those studies that did reasonably address this stage of the process were typically undertaken as part of the LAPP program. The relevant guidelines (Broadleaf Capital International and Marsden Jacob Associates, 2006) provide specific guidance on holding a workshop, brainstorming and providing clear descriptions of the actual risks themselves. Of note, however, is that

those guidelines were based on the 2004 Australian Standard for Risk Management (Standards Australia, 2004), and defined a risk as:

"The chance that something happening that will have an impact on the organisation's objectives"

…which focuses on "chance" (or *likelihood*) only and is somewhat inconsistent with risk being evaluated as a combination of both likelihood and consequences. While the more recent international standard is based on the previous Australian standard, this anomaly has been corrected with the more consistent definition of risk being:

"the impact of uncertainty on objectives"

Even though risks were identified at a workshop as part of these studies, it was common that the assessment only involved facilitators and staff from the local council. While it is reasonable for council staff to make up the majority, a more diverse composition for the workshop would have been desirable. It is true that risk assessment should focus on the objectives of local government. However, local councils do not act in isolation from their community or other tiers of government. In Australia, local government is effectively an agent of state government which exerts control over the way in which local government is to operate. Therefore, it seems imperative that such workshops should involve representation from state government agencies. Similarly, local communities are primary stakeholders. Ideally, risk identification should be more inclusive, including Councillors, broad community representation and local government stakeholders.

Risk Analysis – Likelihoods

The average score for assessed studies was 14.0 out of a possible 25 (Sample Size = 26) and was noticeably negatively skewed (Figure 3). Associating likelihood with a particular level of climate change is a particularly vexing issue. The studies reviewed as part of the research were primarily completed prior to the release of AR5 (IPCC, 2013) and therefore informed by the findings of AR4 (Pachauri, 2007) . Considering sea level rise (probably the most important 'coastal' climate change variable), Hunter (2010) noted that the 5 to 95% ranges that could be derived from AR4 were measures of the uncertainty in the distribution of model estimated sea level rise, and not the distribution of possible future projections. In other words, AR4 provided a measure of how much model results were spread, but it was not considered that this was representative of actual likelihoods.

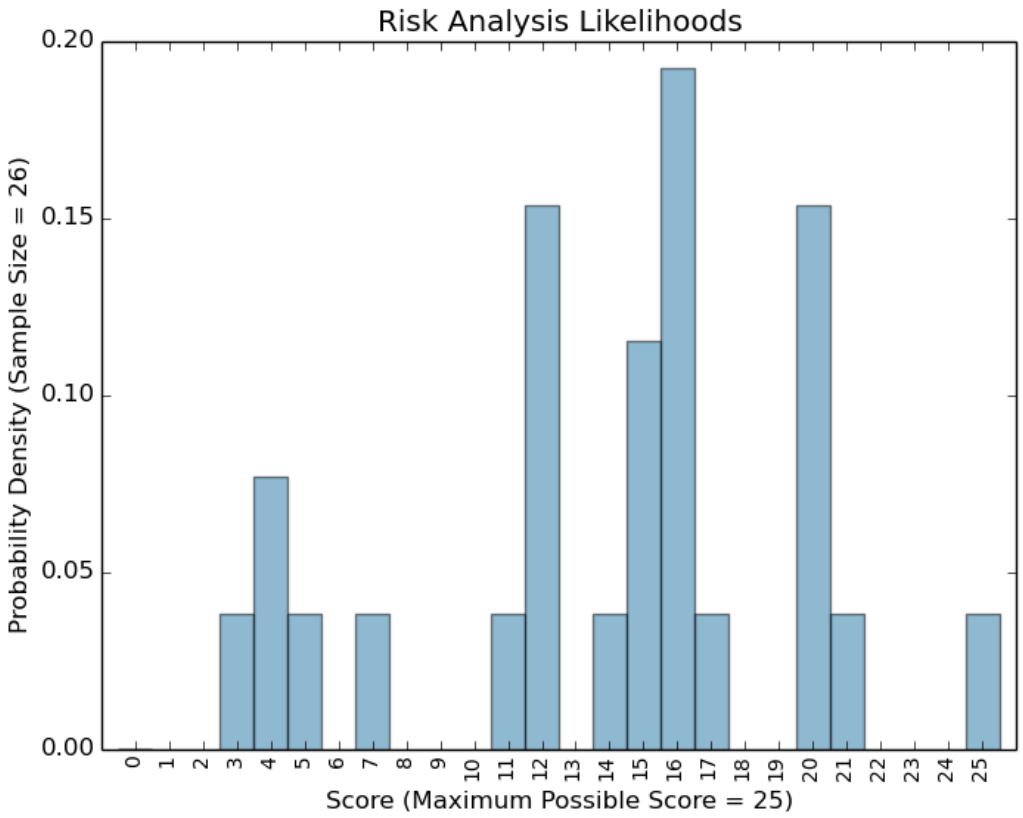

Figure 3 Histogram of Study Results for "Risk Analysis - Likelihoods"

In AR5, the authors have taken the additional step of equating the 5 to 95% of model results with the "Likely" range (~17 -~83%) of foreseeable outcomes (Wainwright et al., 2014). It has therefore become possible to attribute meaningful likelihoods to particular levels of sea level rise at different points in time. However, those likelihoods are still conditional on the adoption of a particular Representative Concentration Pathway (RCP) of which four are provided in AR5. No guidance on the likelihood of any particular RCP is provided in AR5, but all are considered "plausible" and "illustrative".

In the absence of more rigorous advice, councils are therefore led to either consider them to be equally likely, or to undertake independent assessment of the individual likelihoods of different RCP's. This is a task that local councils may be asked to make a decision upon, but it is unreasonable to expect them to have the resources necessary to do so in a meaningful manner.

Aside from the limits to which the results of AR5 could be applied, practitioners are asked to assess risk likelihoods when, at a state level, it is common for a particular projection or "benchmark" of levels at particular points in time to be specified by state governments. Those benchmarks have often been set without any indication of likelihood although they tend to sit, understandably in the absence of a rigorous risk assessment, towards the conservative end of ranges published by the IPCC. There are local polices and guidelines which advocate, for example, that planning decisions are made with due regard to the

precautionary principle in terms of sea level rise (see, for example NSW Government, 1997).

Being cautious in selecting a 'benchmark' could be interpreted as 'precautionary' in line with the principles of ecologically sustainable development (ESD) and adherence to ESD principles is considered to be *in the public interest.* Subsequent adoption of a high benchmark may be considered a prudent approach. However, selecting a particular sea level rise projection (derived for example, from one of the RCP's in AR5, adjusted to local conditions) effectively makes the risk assessment "conditional" and therefore transparent risk-based decisions become more difficult. From a risk assessment point of view, a more robust approach is to consider a wider range of projections, but to be more risk averse when selecting a tolerable risk level.

The present regulatory environment for sea level risk planning in Australia has not allowed for a meaningful assessment of likelihood. The most common approach has been to apply 'benchmark' values, and possibly undertake a sensitivity analysis on consequences for higher and lower values, with those values commonly being provided from modelling by specialised organisations, such as the CSIRO. There was one study which scored full marks for likelihood assessment, as it managed to place meaningful likelihoods onto different sea level rise projections, using the results of AR5. In discriminating between other studies, consideration was given to the rigour applied in transferring sea level rise information to a coastal hazard (such as erosion, shoreline recession or inundation).

A range of methods is available for coastal hazard assessment, from simplistic methods such as the Bruun Rule for recession or the "Bath Tub Method" for inundation assessment, to sophisticated numerical modelling. The applicability of different methods is governed largely by the scope of the assessment and the availability of suitable data. In most instances, studies had access to high quality data such as detailed tide records and LIDAR elevation data. However, some aspects of coastal processes are still poorly understood.

Risk Analysis – Consequences

The average score for assessed studies was 16.7 out of a possible 25 and was strongly negatively skewed (Figure 4).

The consequences side of risk analysis was completed relatively well, although there are notable poor examples, which tend to arise from studies that purport to be full risk assessments, but are primarily hazard assessments. In the context of the responsibilities of a coastal council, the consequences assessment is largely a geographical/spatial problem. Once the extent of hazards for a given likelihood are determined (e.g. elevation when considering inundation or horizontal extent when considering shoreline recession) it is a matter of determining the assets that are spatially exposed, their ability to withstand or recover from that hazard, and the value of the asset.

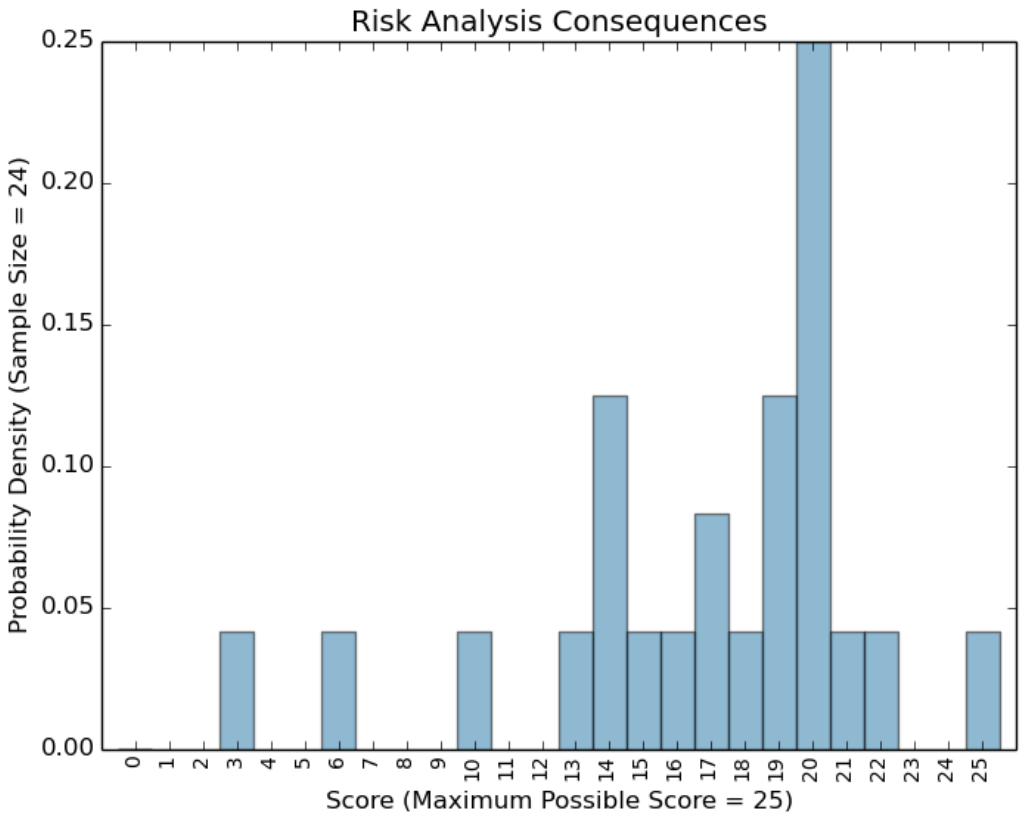

Figure 4 Histogram of Study Results for "Risk Analysis - Consequences"

The assets could come from a range of different types (e.g. infrastructure, private property, public facilities, environmental) and there are many different ways in which values can be assigned. Ideally, a dollar value is assigned, but this is difficult when considering the value of environmental assets and more intangible aspects like beach recreational values. Even so, there are established methods for assessing more intangible aspects and, to facilitate decision making, it is important that values are expressed in a common way to enable a fair comparison of risks.

The majority of studies that actually completed a consequences assessment did so in a cursory and qualitative manner. This was a common approach for studies funded by the LAPP program. However, there were some stand out examples where significant effort was placed on assigning dollar values on intangible aspects of assets.

Risk Evaluation

The average score for assessed studies was 8.4 out of a possible 10 and was, again, strongly negatively skewed (Figure 5).

Our review indicated that most studies completed this in a competent manner. We expect this arises from the availability of a standard risk matrix in order to combine likelihood and consequences with relative ease.

Unfortunately, the results that are produced from risk evaluation, typically assigning levels of “Very High”, “High”, “Medium” or “Low” to each identified risk, can very effectively hide limitations in other aspects of the analysis. In the absence of rigorous analysis and the development of suitable criteria for evaluation, the risk evaluation can be reduced to an overly qualitative assessment which returns results that are in line with the expectations that were present from the outset of the risk assessment process. As the outcome of the process meets the expectations, there is lesser tendency for the results to be scrutinised.

Such an outcome defeats the purpose of the risk assessment exercise. Ideally, it should tease out and evaluate risks which would otherwise have been unexpected and highlighting where the consequences relating to those are unacceptable. The entire process needs to be undertaken with an open mind, for the final risk evaluation to be valid. For this reason, the inputs from a range of stakeholders with different interests and backgrounds are important.

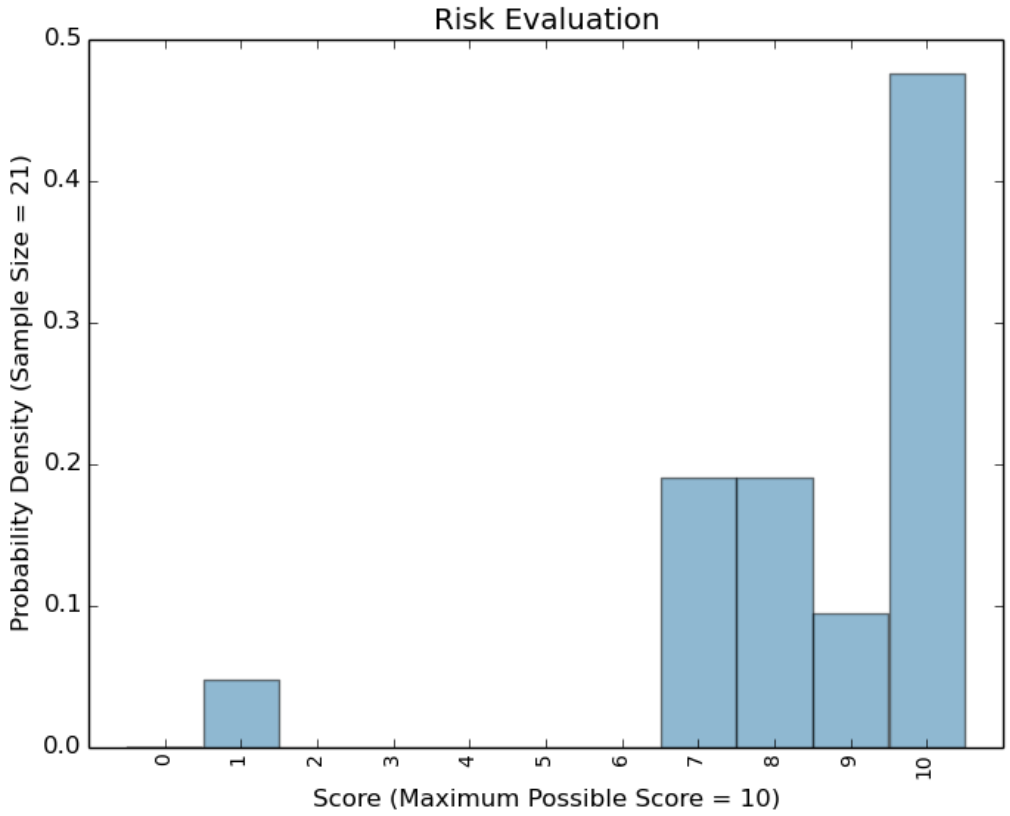

Figure 5 Histogram of Study Results for “Risk Evaluation”

Communication and Consultation

The average score for assessed studies was 8.8 out of a possible 15 with a slight positive skew. A histogram of results is presented in Figure 6.

The results here somewhat reflected the quality of reporting (given the reports were the primary basis of our analysis at this stage). However, higher marks were awarded where it was clear from those reports that efforts were made to consult with stakeholders and the community prior to and following the main risk assessment phase. It was very rare that we could find evidence of communication and consultation following the model demonstrated in ISO 31000. Therein, reporting and feedback with stakeholders is indicated at every step of the process, including having inputs to risk identification and the methods that are to be used for risk analysis.

There was limited evidence that stakeholders were actively engaged when deciding the appropriateness of different methods that would be used throughout the risk assessment process, including those used in analysing risks.

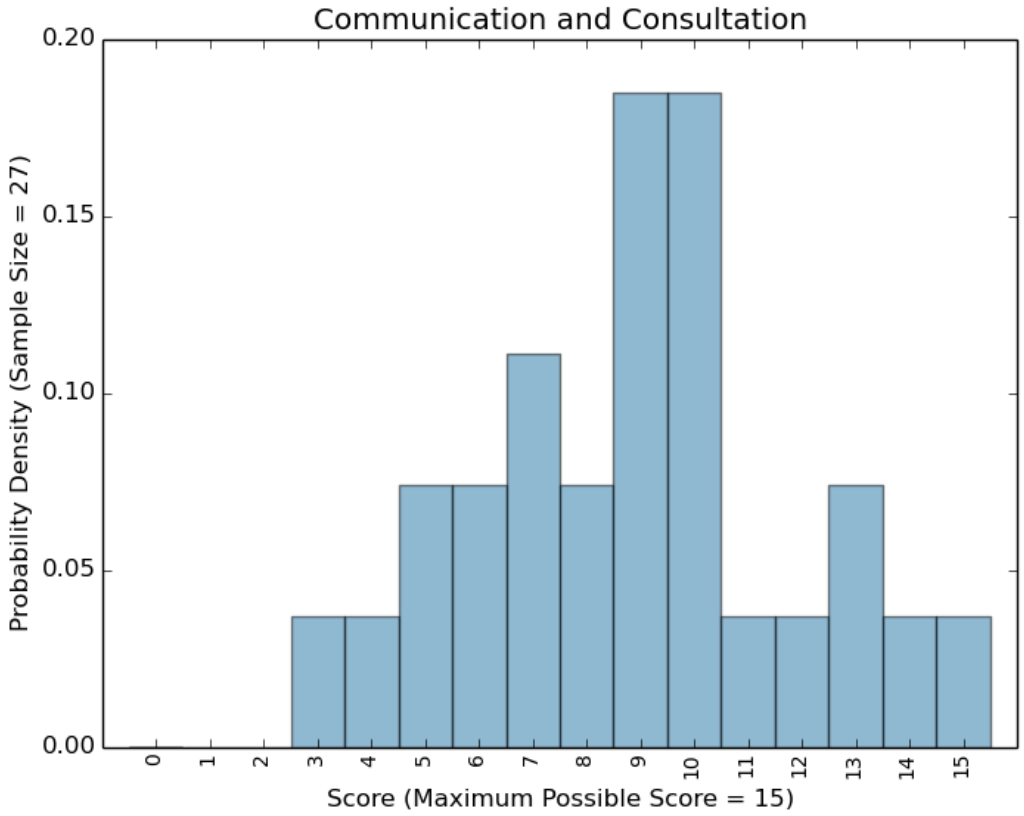

Figure 6 Histogram of Study Results for "Communication and Consultation"

Key Findings and Conclusions

As part of our research, follow up contact was made with six of the organisations that had produced risk assessments that performed best against our scoring methodology. Detailed follow up interviews were subsequently arranged with three of those organisations. Based on those interviews and our overall review of the studies undertaken during the research effort, a number of key findings and recommendations regarding best practice coastal climate change risk assessment were determined as follows:

- The key driver of coastal climate change risk is sea level rise although changes to storminess are also important. Sea level rise will exacerbate coastal erosion, inundation and flooding with consequences to various assets such as infrastructure, settlements, beaches and ecological communities.
- Local government is the at the front line of government responsible for coastal climate change adaptation planning in Australia, with local councils commonly engaging a third party (consultant, CSIRO) to undertake detailed studies;
- Those risk assessments should meet the needs of Council as the primary risk owner. Council should be pro-active and involved in appropriately establishing the context for any detailed studies. This should include geographical extent, time frames, legal environment, hazards to be considered and the expected level of assessment and deliverables. Some of this context is more appropriately standardised at the State Government level;
- As an entry to the risk assessment process, it is recognised that at least some risk information needs to be prepared to open a conversation with the full range of stakeholders. A scoping 'preliminary' study, which also doubles as a means for 'hot-spot' identification is recommended;
- Broad, continuing consultation is very important. This requires significant effort and can be uncomfortable;
- Genuine attempts should be made to address uncertainty. This will take significant effort to complete successfully. We recommend that a probabilistic approach, with appropriate likelihoods assigned to different climate change scenarios be adopted. The use of 'benchmark' settings without consideration of likelihood is not considered 'best-practice';
- Extra care is needed when using terms such as sensitivity, hazard, exposure, vulnerability and adaptive capacity. Wherever possible, nomenclature should adhere to that of ISO 31000. In particular, 'vulnerability' is a particularly nebulous term with many varied definitions used in practice. Under ISO31000, "Vulnerability" is not interchangeable with "Risk";
- Numerous "guideline" documents exist to undertake risk assessment. These are often generic and not of direct applicability to coastal climate change risk assessment nor the needs of local government. In the absence of a directly applicable guideline document, the NCCARF *CoastAdapt* Tool is aiming to provide relevant assistance to Local Government in Australia.

Frameworks for coastal climate change assessment should recognize and aim to incorporate these findings.

Acknowledgements

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